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SIZING STUDY - LABORATORY RAYMOND AIR CLASSIFIER

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SIZING STUDY - LABORATORY RAYMOND AIR CLASSIFIER

by

J.-M. Lamothe*

SUMMARY

The separation characteristics of a Raymond small capacity mechanical air classifier were evaluated using ground, minus 150 μm calcite as feed material. Separation was varied from "fine" to "coarse" using various combinations of internal fans and blades. Results indicated that fine products of 90% wt passing 9 μm were possible at the finest setting, and up to 90% wt passing 172 μm at the coarsest setting. Recovery of particles smaller than the cutting size and found in the fine product was higher with the larger fan, but decreased when the number of blades in the whizzers were increased. Recovery of the fine particles in one pass varied from 90% wt for the coarsest setting to 65% wt at the finest.

Keywords: air classifier, sizing, fine particle

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ÉTUDE DE CALIBRAGE - CLASSIFICATEUR PNEUMATIQUE DE LABORATOIRE RAYMOND

par

J.-M. Lamothe*

RÉSUMÉ

On a étudié les caractéristiques de séparation d'un classificateur pneumatique mécanique Raymond à faible rendement en utilisant le calcite broyé de moins 150 µm comme matériau d'alimentation. Les particules étaient séparées selon des dimensions allant de "fines" à "grosses" au moyen de différentes combinaisons de ventilateurs et de pales internes. Les résultats ont démontré qu'il était possible de faire passer le produit fin de 90 % en poids dans un tamis de 9 µm au calibrage le plus fin et jusqu'à 90 % en poids dans un tamis de 172 µm au calibrage le plus gros. Le taux de récupération des particules plus petites que la dimension de coupure et trouvées dans le produit fin était plus élevé lorsque l'on utilisait le ventilateur plus gros, mais diminuait lorsque le nombre de pales dans la colonne sécheuse était augmenté. La récupération des particules fines dans une passe variait de 90 % en poids au calibrage le plus gros à 65 % en poids au calibrage le plus fin.

MOTS-CLÉS : classificateur pneumatique, calibrage, particule fine.

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INTRODUCTION

Air classification of minerals in the ultrafine range (<10 μm) is a difficult task because of the inefficient separation characteristics of many types of classifiers. In this size range, the number of particles, bulk volume and particle surface area increase dramatically over those of a larger size, e.g. 20 μm, resulting in reduced efficiency of classification.

This study deals with the evaluation of a laboratory Raymond classifier. The results can be used to help in the selection of proper settings for subsequent use.

PRINCIPLE OF RAYMOND CLASSIFIER

The self-contained Raymond classifier (Fig. 1) consists of a chamber in the shape of a double vertical measuring 25 cm. diam. by 45 cm. high, a motor having a long shaft extension into the separating chamber, and shaft-attached fans and blades. Material is fed to the bottom of the inner chamber via a screw-type feeder where it is scattered by a distribution plate. Particles are then carried upward in the inner chamber by circulating air where they pass through two whizzers. Heavy and/or large particles are thrown against the inner chamber walls by centrifugal force where they slide down and discharged into a coarse product bag. Finer particles passing through the whizzers are carried up by the air current and pass into the outer chamber where they settle and eventually exit into a fine product bag.

Although the flowrate of air in the unit is adjustable only by changing the fan size, the size of products may be varied by changing the whizzer blades. There are two sizes of fan, 13 and 19 cm in diameter and, in all, 4 whizzer blades with 6, 12, 16 and 24 blades respectively. These may be located at position A or B, as noted in the diagram, Fig. 1. A proper selection of fan and combination of whizzer blades is required in order to obtain a product of specific size.

SAMPLE DESCRIPTION

A relatively pure calcite sample from Ontario was used as head material for the tests performed. The material was prepared by crushing, pulverizing, sizing with screens and combining different size products to obtain a sample with a wide particle size distribution. The latter was then divided by a Carousel splitter into equal fractions which were bagged separately. Each sample was dried in an oven to eliminate free moisture before use. Various combinations of fan size and whizzer blades were tried at constant feed rate of ± 100 g/min.

RESULTS AND DISCUSSION

Table 1 presents the various fan/whizzer blade combinations for the twelve tests and Table 2 the results of size analyses on all products. The size analyses were made using a Microtrac particle size analyzer. These results were used to calculate the size of screen that would retain only 1% wt and 10% wt of each "fine" product, commonly called D99 and D90. These sizes are reported in Table 3.

As expected, the fineness of the fine products was directly related to the number of whizzer blades and indirectly to the size of the fan in the classifier. These relations can be seen in Fig. 2. A linear relation between the logarithm of the cutting size produced and the total number of blades used was found despite the limited number of tests performed. Separation tests without whizzer blades were meaningless because no inertial force from the blades would be generated to separate particles.

In test 1, using the small fan with 24 blades in the top and 12 blades in the bottom, the fine product contained 99% wt minus 21 μm and 90% wt minus 13 μm. The results corresponded to the finest material produced during the tests. However, linear extrapolation of these with the results of the subsequent tests indicated a possibly finer product using 24 blades in the top

and 16 blades in the bottom. In this case, although it was not investigated, a fineness of 99% wt minus 16 μm and 90% wt minus 9 μm could be possible.

In each test, a certain amount of fines was found in the coarse product indicating imperfect separation. To evaluate the magnitude of this effect, the recovery of fine particles was determined by measuring the accumulating amount of particles in the fine product smaller than, say, D99 over those of the same cut size found in the calculated head. Generally, recovery of D99 size was higher when the cutting size was greater, or when the number of blades was decreased (Fig. 3). In the series of tests with the larger fan, the recovery of material finer than D99 in the fine product dropped from 96-98% using 6 blades to 82% using 40 blades. However, using the smaller fan, the recovery of same material finer than D99 in the fine product dropped dramatically when the number of blades was increased, passing from 95% with 6 blades to 65% with 36 blades.

Considering any separation at a cut size (D99) larger than 40 μm, the separator worked best using the larger fan and the proper number of blades. For an equivalent fine product, the use of the larger fan aided in recovering more material than with the smaller fan and fewer whizzer blades. However, with the larger fan, the separator was not able to produce a desired product with a top size finer than 40 μm.

CONCLUSIONS

Using calcite as feed material, the coarsest setting, using the large fan and 6 whizzer blades in the Raymond laboratory air classifier, gave a fine product of D99 of 310 μm and D90 of 170 μm. Based on linear extrapolation of the results, the finest product possible with calcite was D99 of 16 μm and D90 of 9 μm, using 40 whizzer blades and the smaller fan.

Recovery of fine product was indirectly related to the fineness of product and the number of whizzer blades. Recovery varied from 98% at the coarsest setting to 65% at the finest setting. The classifier with the larger fan was not able to produce a fine product with a D99 below 40 μm. Above this

limit, the larger fan was more efficient than the smaller fan in producing similar products. Below the cut size of D99 of 40 μm, the classifier was able to classify using the smaller fan, but with low recovery.

Finally, the laboratory classifier was not able to produce any fine product with a D99 below 10 μm (i.e. an ultrafine product).

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Table 1. Fan Size and Number of Blades on Whizzers

Test No.	Fan Size	Number of Blades	
		Upper Whizzers	Lower Whizzers
1	Small	24	12
2	Small	24	6
3	Small	12	-
4	Small	6	-
5	Small	-	-
6	Large	24	16
7	Large	24	6
8	Large	6	24
9	Large	16	6
10	Large	12	-
11	Large	6	-
12	Large	-	-

Table 2. Particle Size Distribution

Size (μm)	% WEIGHT PASSING											
	Test # 1		Test # 2		Test # 3		Test # 4		Test # 5		Test #6	
	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse
5000		99.5		98.7		98.5		97.9		91.8		98.4
2500		91.3		91.3		86.6		85.5	100	46.9		90.4
1000		73		73		60.8		59.6	92.3	22.1		71.4
630		60		59.9		43	100	41.2	81.5	18.2		57.3
400		50		49.9		29.7	99.9	27.2	71.4	16.1		46.5
315		45.3		45.1		23.6	99.8	20.6	66.3	13.1		41.3
200		37.3		37.2		14.5	98.5	10.4	56.9	11.8		32.8
160		33.5		33.4		11	95.9	7.1	52.4	11.2		29.2
125		32.9		32	100	9.9	95.5	6.7				27.7
88		29.7		28.4	94.3	8.3	86.8	6.1				24.7
62		23.8		23.4	84.3	7	76.4	5.5				16.7
44		20.3	100	19.3	77.6	6.5	68.1	5.3			100	11.2
31	100	16.6	98.4	15.6	68.7	6.1	60.1	4.8			98.5	7.9
22	99.5	13	95.1	12.6	61.4	5.5	54.5	4.2			84.1	5.7
16	94.6	10.7	88.1	10.6	55.5	4.7	46.3	3.8			71.8	4.2
11	87.2	8.2	79.6	7.7	49.9	4.1	41.4	3.3			61.4	3.2
7.8	77.2	6.1	69.3	6.7	42.5	3.6	35.3	2.9			51.2	2.9
5.5	67.6	5.3	59.8	6.2	36.7	2.9	30.3	2.6			43	2
3.9	56.2	3.6	49.5	4.4	30.5	2.3	25.4	2			35.2	1.5
2.8	44.8	1.7	39.1	2.8	24.6	1.7	19.4	1.5			27.8	1.2
1.9	26	.3	22	1	14	.9	10.5	.9			15	.3

Table 2.(cont'd)

Test # 7		Test # 8		Test # 9		Test # 10		Test # 11		Test #12		Head
Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	Fine	Coarse	
	97.7		99.3		98.4		98		97.2	100	89.9	99.2
	89		90.3		90.1		86.6		81.2	99.8	32.2	92.5
	69.3		69.3		70.2		59.1		50.9	93.1	19.7	78.0
	54.4		53.9		54.4		40	100	31	83.5	16.5	68.0
	42.8		41.9		41.8	100	25.7	99.7	17.8	73	14.3	60.6
	37.2		36.2		35.6	99.9	19.4	99.1	12.6	67.4	13.4	57.1
	28.1		26.8		25.4	98.8	9.9	94	5.7	56.8	11.9	52.0
	24.3		22.7	100.0	21.1	96.8	6.6	88.3	3.8	51.4	11.4	50.1
	21.5		20.9	99.7	18.3	94.6	5.7					44.5
100	16.7		15.5	95.7	12.3	85.7	4.5					46.1
98.8	11.8	100	9.4	91.2	8.1	80.8	3.6					40.9
95.3	8	94	7.3	84.3	5.7	71.4	3.4					37.7
88.2	6.7	85.3	6.2	76.2	4.9	63.3	3.3					33.6
78.8	5.4	76.8	4.8	69.6	4.7	56.4	3.2					30.0
68.3	4.4	69.3	3.9	62.2	2.8	49.9	2.7					27.0
60.5	3.9	60.4	3.5	57.3	2.2	43.7	2.6					24.2
51.9	3.4	50.6	2.7	51.3	2.2	37.5	2.4					20.7
44.1	2.3	44.6	1.8	47.4	1.5	32.1	2.1					17.7
36.9	1.9	35.8	1.3	34.4	1	26.8	1.8					14.7
30.2	1.9	27.8	1.1	24.5	.5	22.9	1.5					11.8
18	7	14	.3	15	.1	13.6	1.1					6.7

Table 3. Wt % Recovered, D99 and D90 of Finer Product

Test #	Classified Products (fines)		
	% Tot Wt (each test)	D99 (microns)	D90 (microns)
1	12.9	21	13
2	17.4	36	18
3	43.9	119	77
4	51.6	244	102
5	85.7	2300	920
6	19.9	35	26
7	28.3	66	34
8	31.7	59	38
9	44.0	119	59
10	48.2	220	106
11	59.6	310	170
12	90.7	2300	880

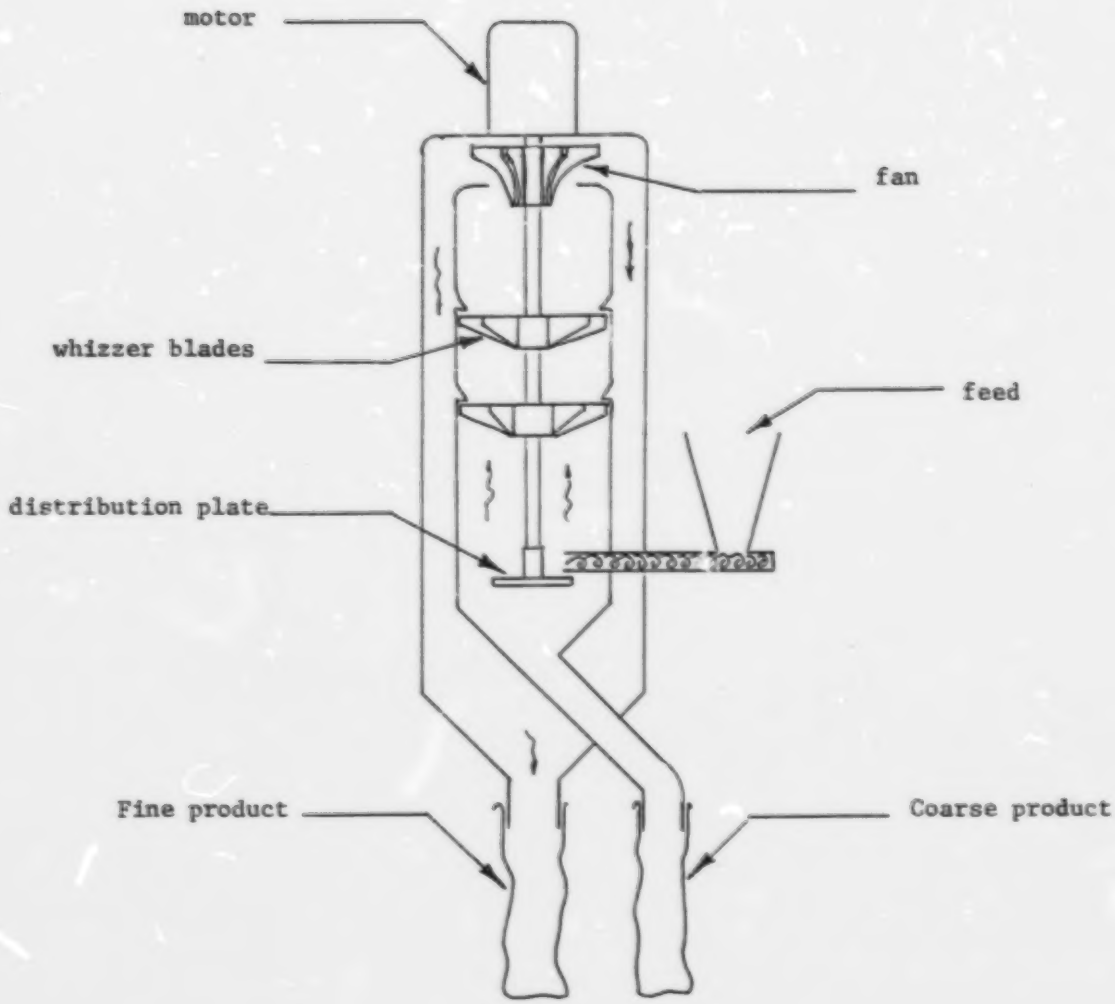

Fig. 1 - Schematic of Raymond Laboratory Air Classifier.

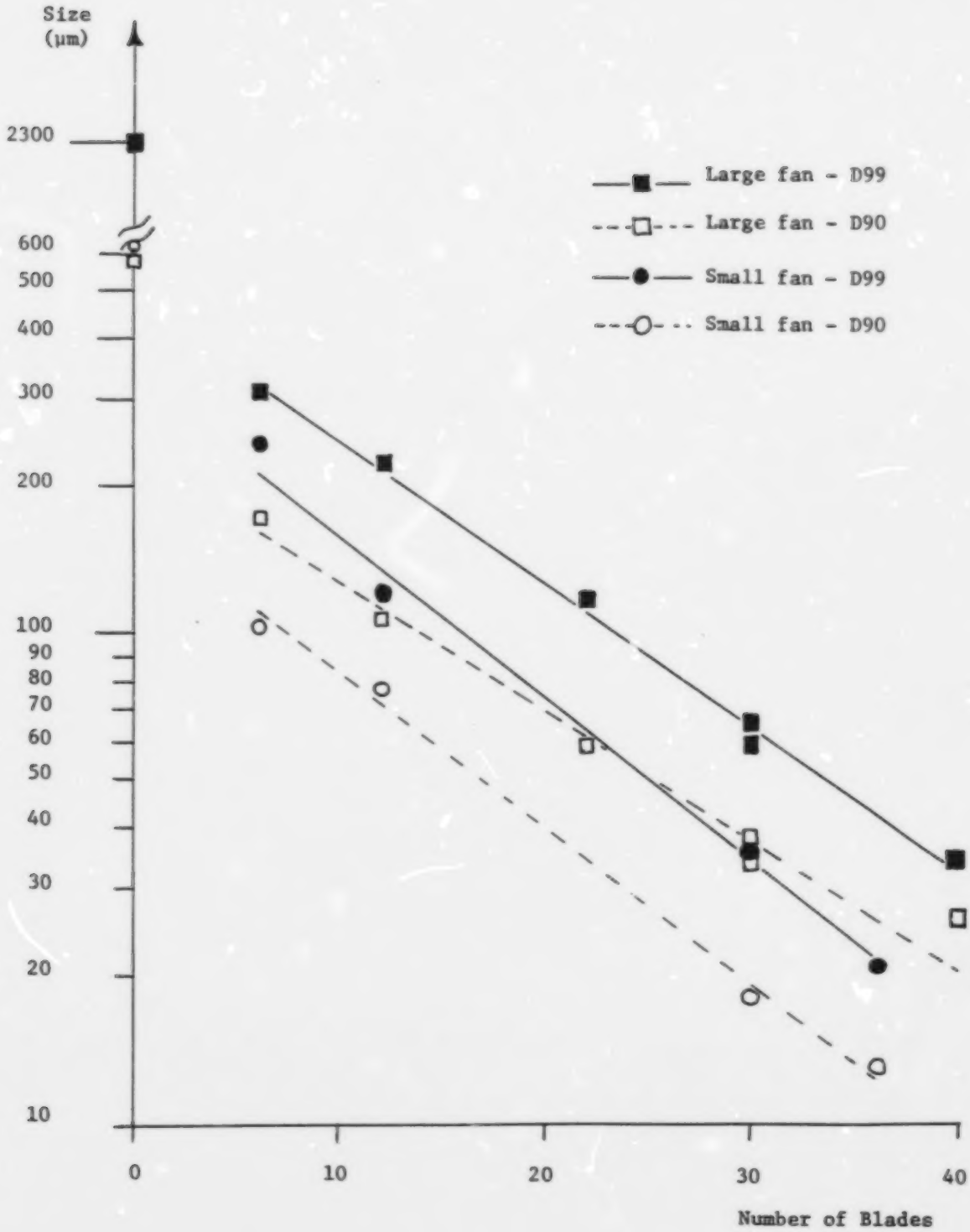

Fig. 2 - Cutting size in microns as a function of total number of blades in classifier.

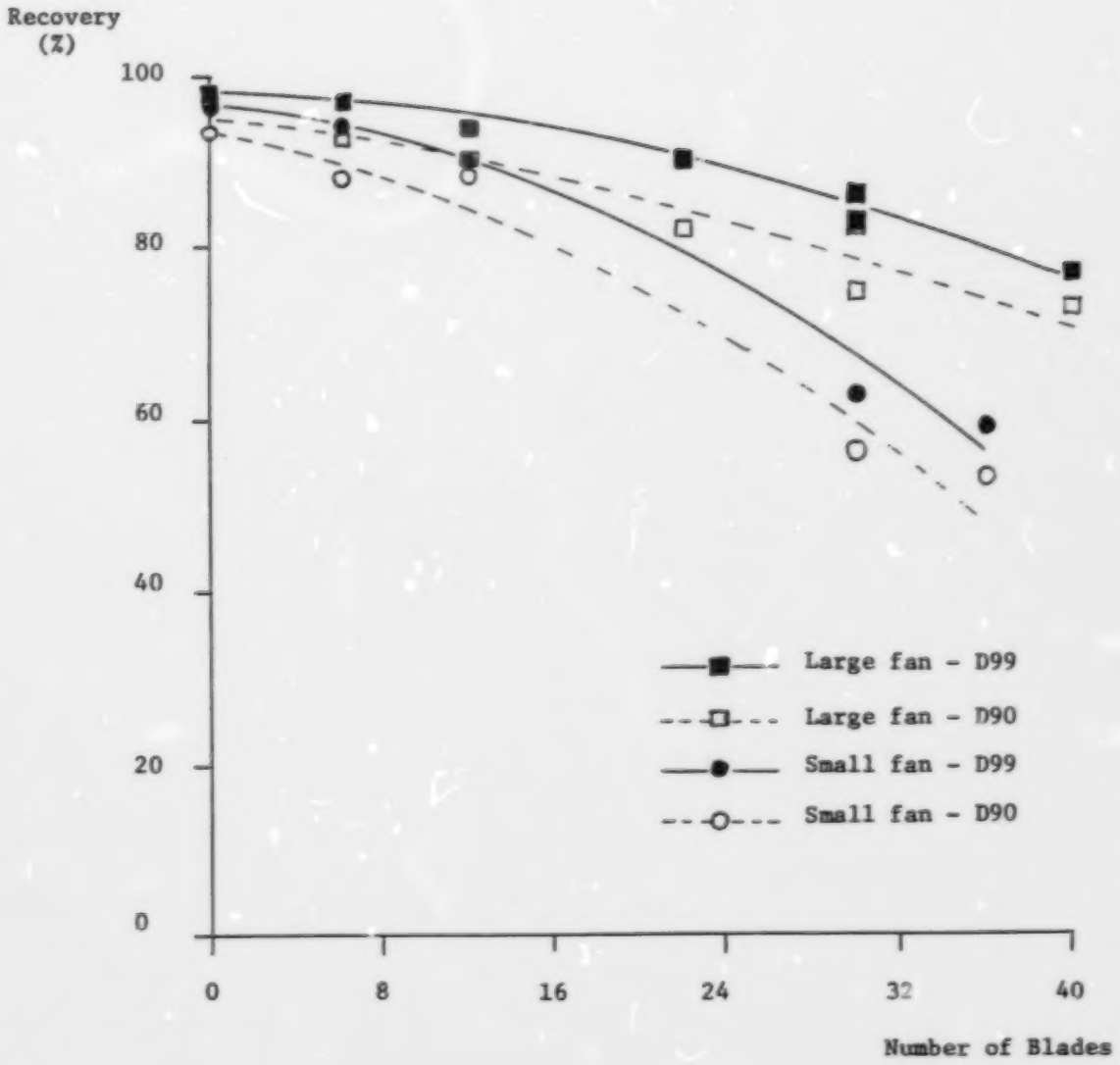

Fig. 3 - Recovery of material finer than D99 and D90 in fine product as a function of total number of blades in classifier.